**NATIONAL TRANSPORTATION SAFETY BOARD**
**Office of Aviation Safety**
**Washington, D.C. 20594**

**April 18, 2022**

# HELICOPTER SPECIALIST'S FACTUAL REPORT – ADDENDUM 1

**NTSB No: ERA20FA074**

## A. ACCIDENT

| | |
|---|---|
| Operator: | Redmark Capital LLC |
| Aircraft: | Robinson R66, registration N450MC |
| Location: | Mechanicsburg, Pennsylvania |
| Date: | January 9, 2020 |
| Time: | 2029 eastern standard time |

## B. GROUP

A group was not formed.

## LIST OF ACRONYMS

| | |
|---|---|
| EFIS | electronic flight instrument system |
| EMU | engine monitoring unit |
| EST | eastern standard time |
| N1 | engine gas producer speed |
| N2 | engine power turbine speed |
| NTSB | National Transportation Safety Board |

## C. SUMMARY

On January 9, 2020, about 2029 eastern standard time (EST), a Robinson R66 helicopter, N450MC, experienced an inflight breakup near Mechanicsburg, Pennsylvania. The private pilot and one passenger were fatally injured and the helicopter was destroyed. The helicopter was operated under the provisions of Title 14 *Code of Federal Regulations* Part 91 as a personal flight. Night visual meteorological conditions prevailed at the time and no flight plan was filed for the flight. The flight originated from Martin State Airport, Baltimore, Maryland, about 1958 EST and was destined for Buffalo Niagara International Airport, Buffalo, New York.

## D. ADDITIONAL INFORMATION

### 1.0 ACCIDENT HELICOPTER PITCH AND ROLL DATA

The accident helicopter was equipped with a Garmin GTN 750 panel-mounted GPS receiver and a Garmin GDU 1060 electronic flight instrument system (EFIS). Data was recovered from both devices by the National Transportation Safety Board (NTSB) Vehicle Recorders Laboratory in Washington, District of Columbia.[1] The recovered data included the accident flight. Using an excerpt of the data recovered from the GDU 1060, **Figures 1 through 3** are graphs of the pitch and roll values of the accident helicopter leading up to the end of recorded data, showing an oscillatory trend that begins with increasing amplitude over time.

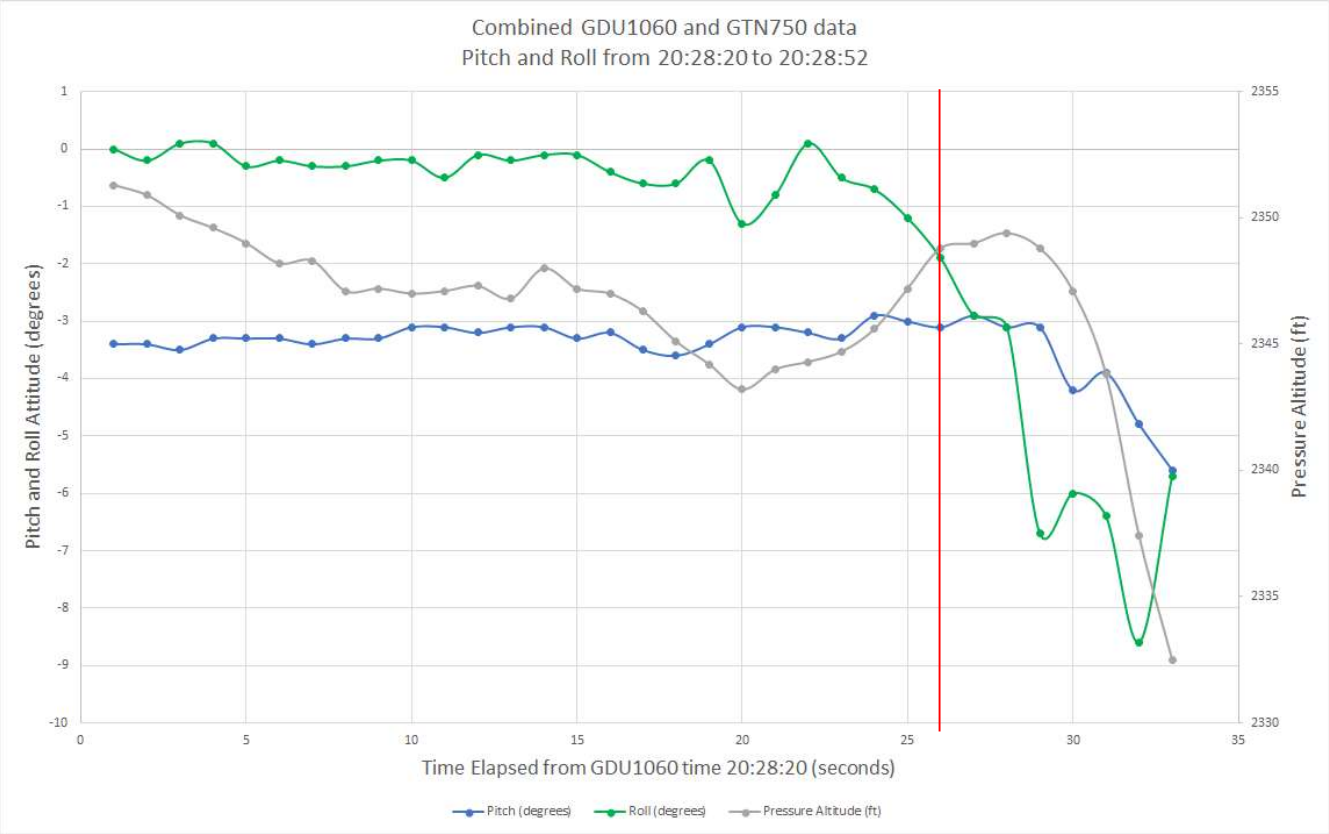


**Figure 1. Steady-state pitch and roll values leading up to the start of notable oscillations around 20:28:46 (red line). For the roll parameter, negative degree values equates to a left roll.**

[1] For additional details of the data recovery and the recovered data, see the *Global Positioning System Devices Specialist's Factual Report* in the docket for this investigation.

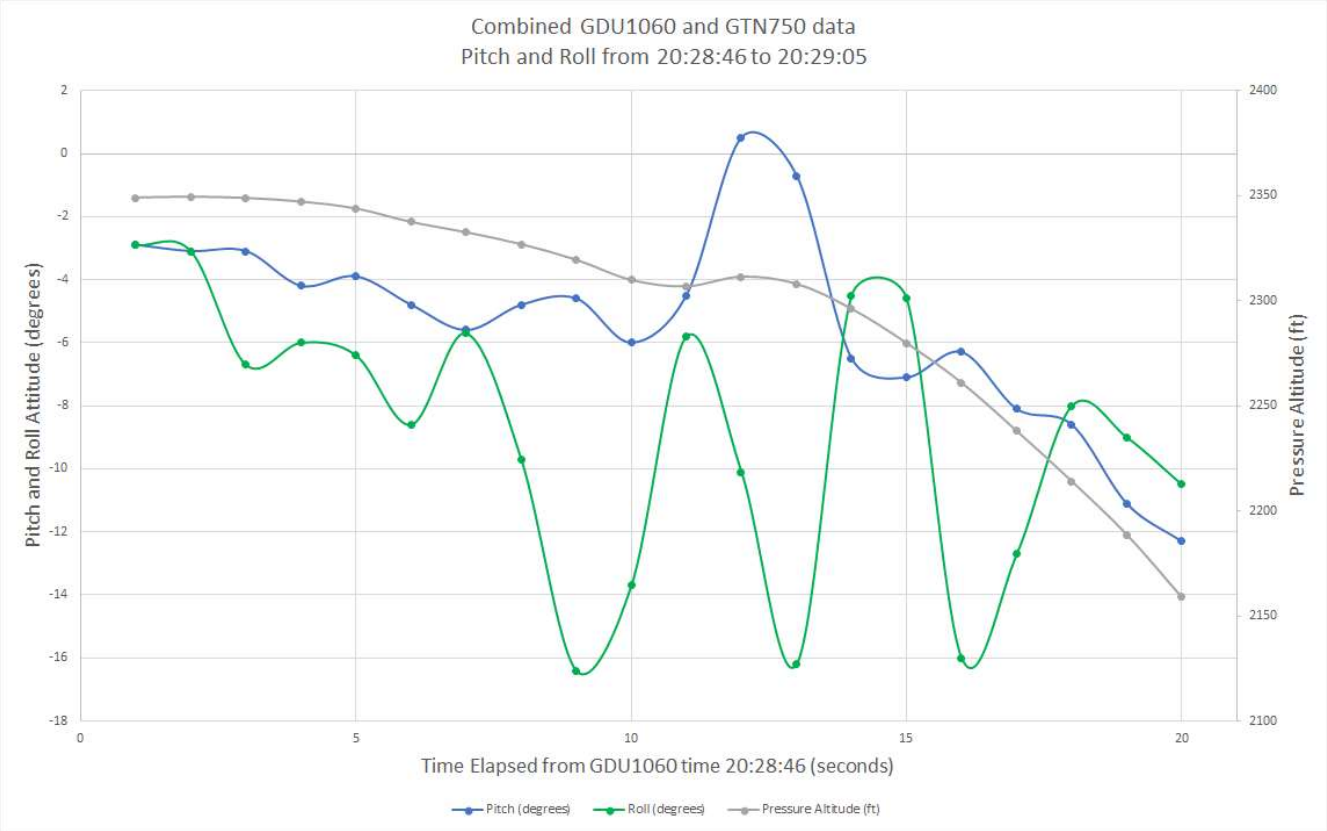


**Figure 2. Pitch and roll values over a 19 second period of growing pitch and roll oscillations.**

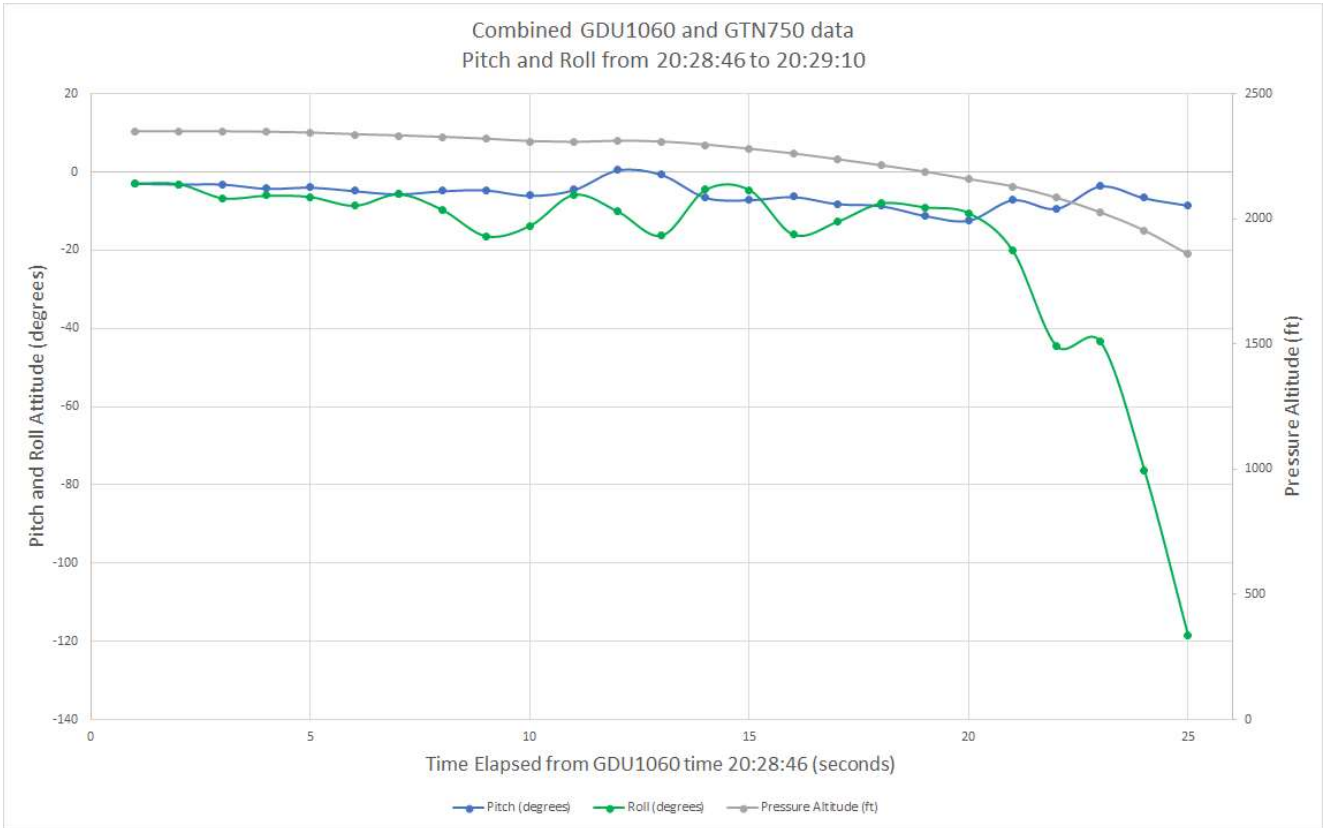


**Figure 3. Pitch and roll values from the 19-second period of growing pitch and roll oscillations (Figure 2) in addition to the 5 seconds in which the helicopter rolls continues to roll left.**

## 2.0 GARMIN GPS AND ROLLS-ROYCE EMU DATA SYNCHRONIZATION

The Rolls-Royce RR300 engine has an engine monitoring unit (EMU) that records certain engine parameters. The data from the accident EMU was recovered at Triumph Engine Control Systems in West Hartford, Connecticut under the oversight of the NTSB.[2] There was no common data parameter between the EMU dataset and the GTN 750 and GDU 1060 datasets that would allow for convenient synchronization of the datasets.[3] A synchronization of the datasets was estimated using data collected from flight testing of an exemplar R66 helicopter by Robinson to correlate certain parameters at takeoff, such as aircraft attitude and engine torque, between the datasets.[4] For example, **Figure 4** shows how a qualitative assessment was used to compare the attitude and torque values at liftoff to create a close match with the available datasets.

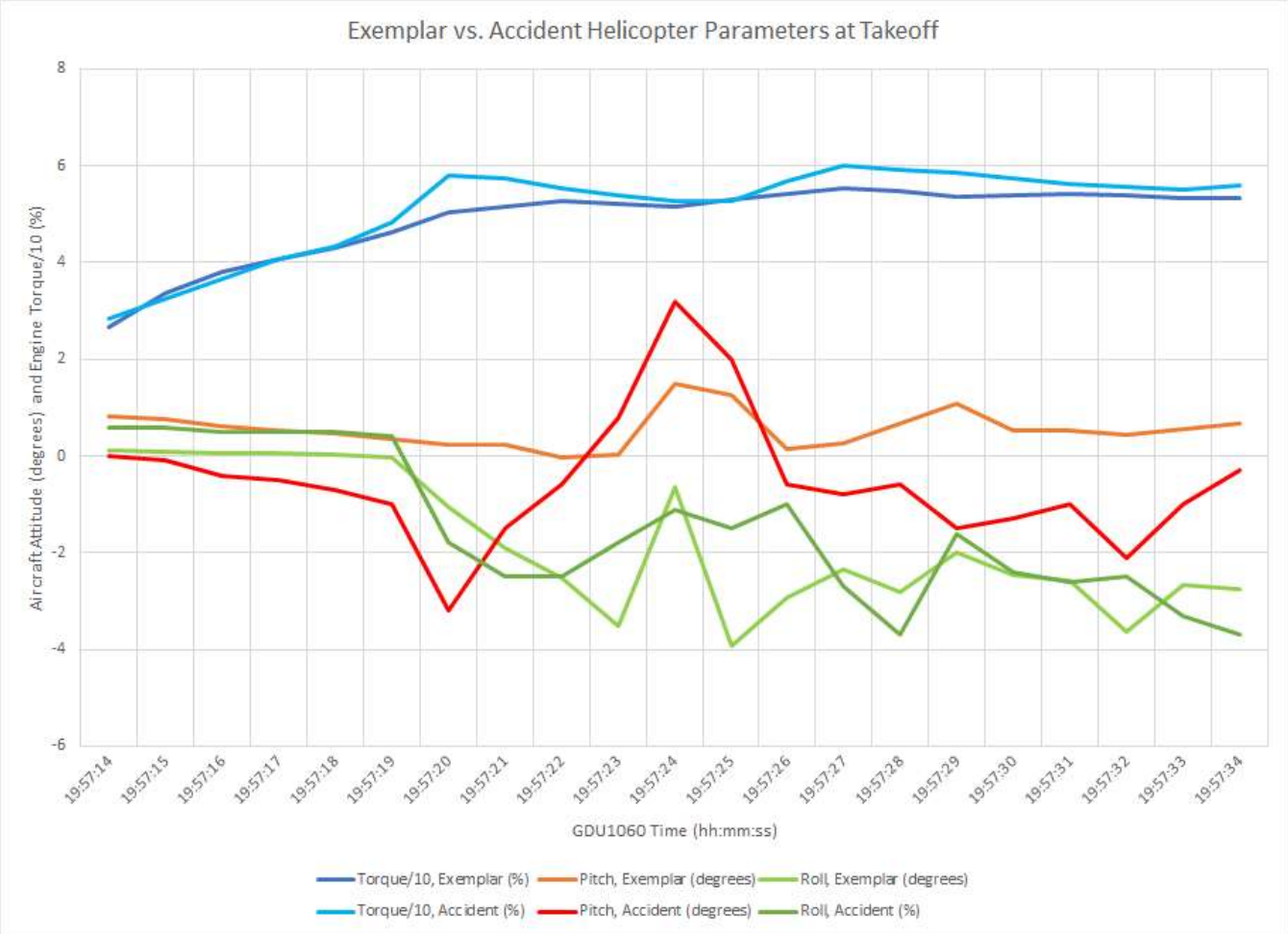


**Figure 4. Helicopter attitude and engine torque parameters at liftoff. The accident helicopter's attitude and engine torque data at liftoff are matched to the exemplar helicopter's liftoff dataset, the latter of which already had synchronized engine torque and attitude data.**

[2] For additional details on the data recovered from the EMU, see the *EMU Summary Report* and *EMU Downloaded Data* in the docket for this investigation.
[3] The GTN 750 and GDU 1060 use a common clock, so no synchronization of those datasets were required.
[4] For additional details on the methodology of the correlation based on flight testing of an exemplar R66 helicopter, see the docket for this investigation.

Based on the estimated synchronization, the time offset between the GDU 1060 and EMU datasets was estimated to be about 2 minutes and 23 seconds, i.e. subtracting the time offset from the EMU dataset would synchronize it to the GDU 1060 dataset. Using an excerpt of the synchronized datasets, **Figures 5, 6, and 7** show graphs of the behaviors of helicopter and engine parametric data near the end of recorded data. **Table 1** contains the tabulated data used to create **Figures 5 thru 7**.

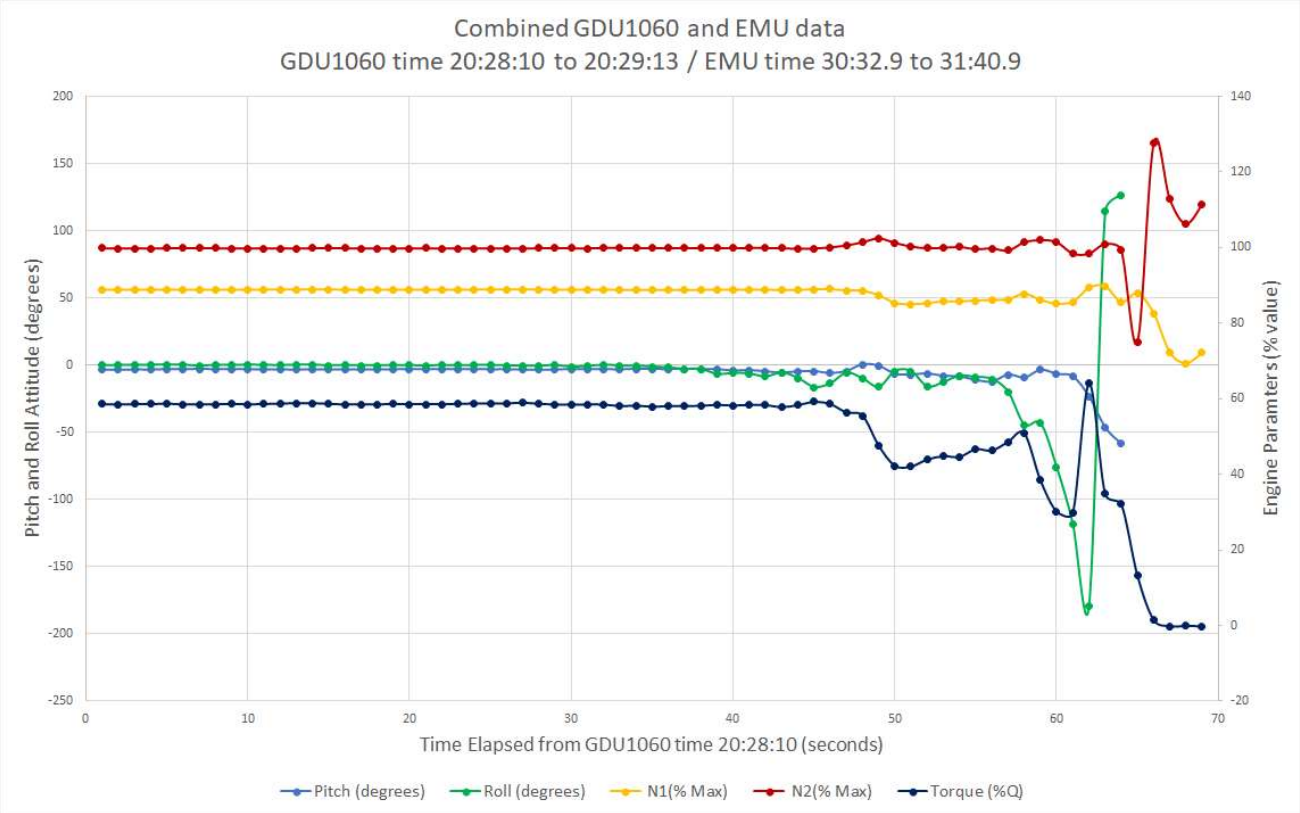


**Figure 5. The synchronized GDU1060 and EMU datasets showing the behavior of helicopter pitch and roll attitudes as well as engine parameters near the end of recorded onboard data.**

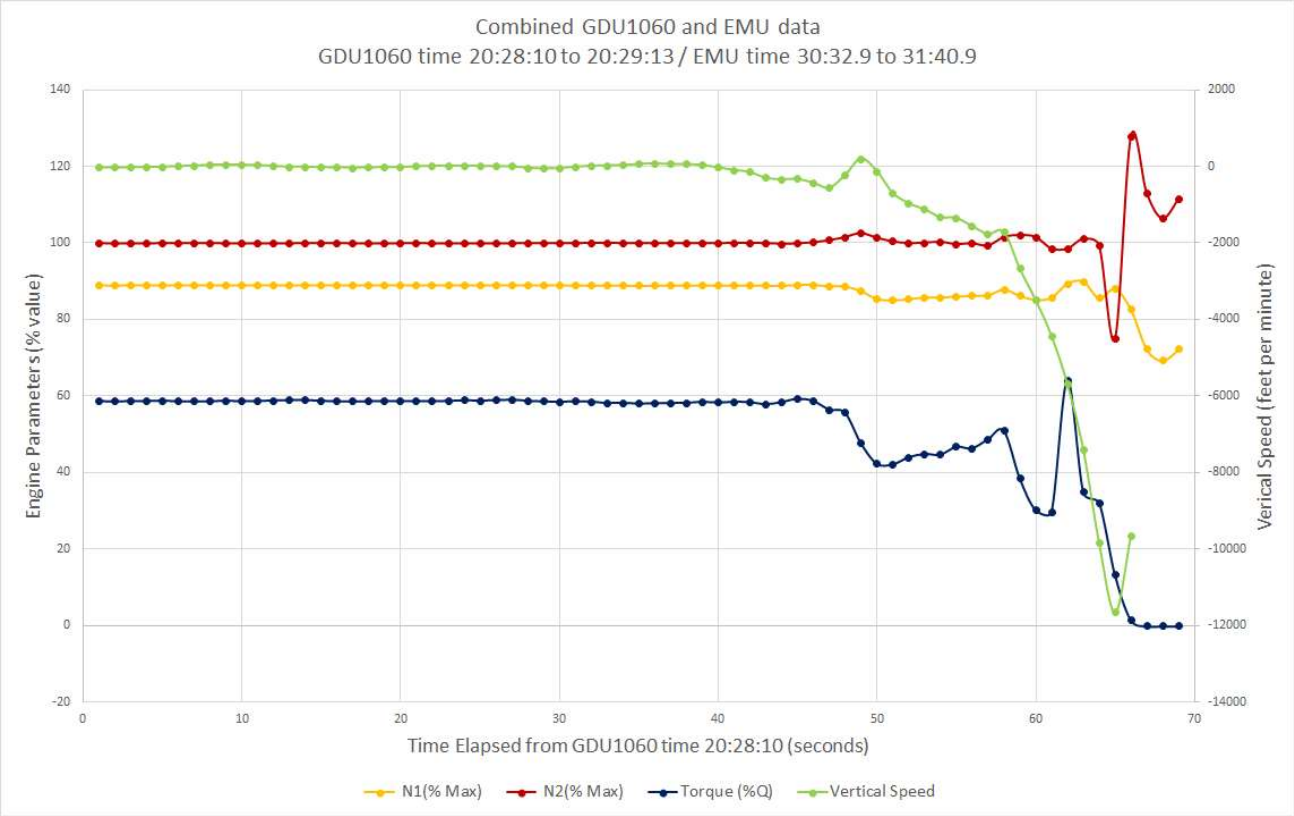


**Figure 6. The synchronized GDU1060 and EMU datasets showing the behavior of helicopter vertical speed as well as engine parameters near the end of recorded onboard data.**

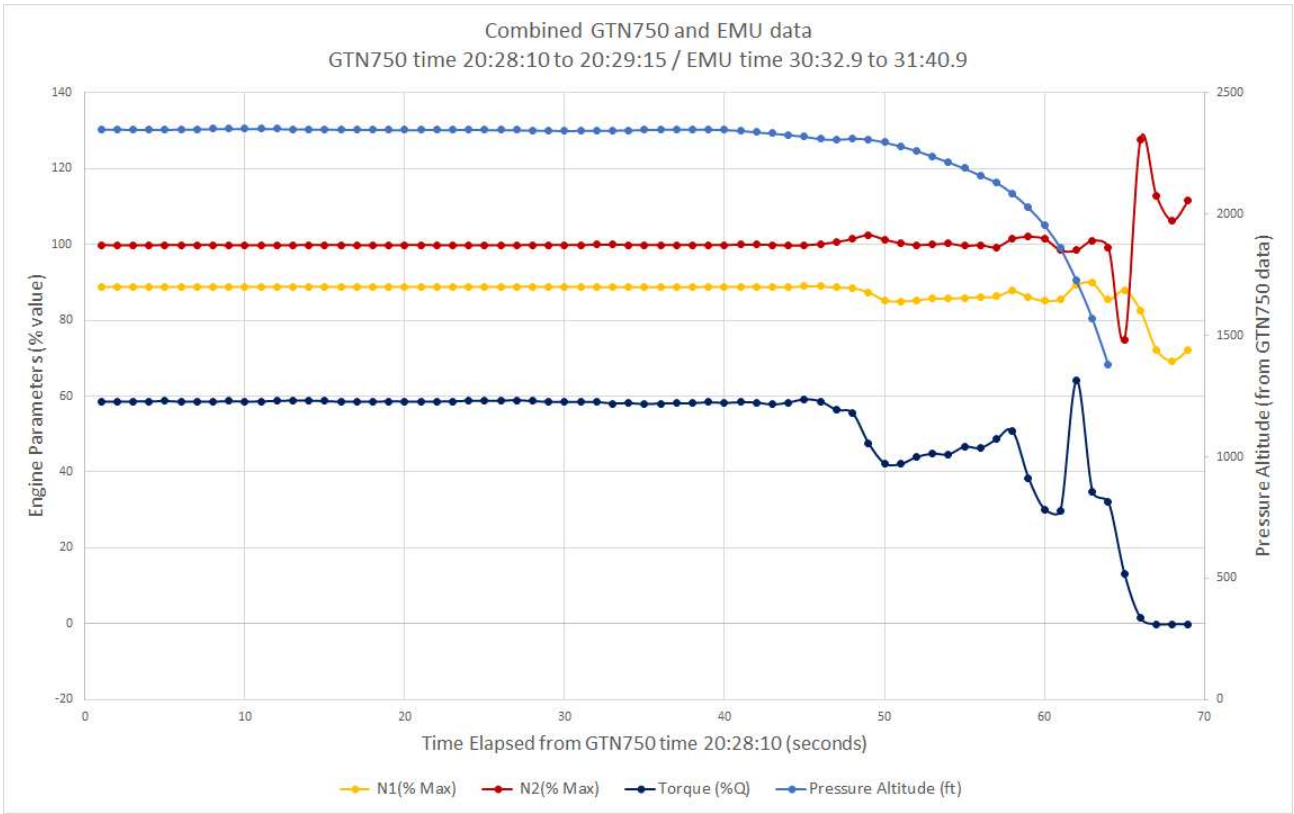


**Figure 7. The synchronized GTN750 and EMU datasets showing the behavior of helicopter pressure altitude as well as engine parameters near the end of recorded onboard data.**

**Table 1. Selected parameters from the GDU 1060, GTN 750, and EMU datasets. All times shown are synchronized to the GDU 1060 dataset. The pitch, roll, and vertical speed parameters were obtained from the GDU 1060 dataset and the pressure altitude parameter was obtained from the GTN 750 dataset. N1, N2, and torque were obtained from the EMU dataset.**

| GDU 1060 Time | Pitch | Roll | Vertical Speed | Pressure Altitude | N1 | N2 | Torque | EMU Time |
|---|---|---|---|---|---|---|---|---|
| (hh:mm:ss) | (degrees) | (degrees) | (ft/s) | (ft) | (%) | (%) | (%) | (mm:ss.s) |
| 20:28:10 | -3.6 | -0.2 | -35.4 | 2349.4 | 88.86 | 99.844 | 58.582 | 30:32.9 |
| 20:28:11 | -3.6 | -0.1 | -39.4 | 2348.7 | 88.825 | 99.763 | 58.494 | 30:33.9 |
| 20:28:12 | -3.4 | -0.1 | -35.4 | 2348.1 | 88.846 | 99.817 | 58.582 | 30:34.9 |
| 20:28:13 | -3.5 | 0.1 | -23.6 | 2347.6 | 88.853 | 99.763 | 58.582 | 30:35.9 |
| 20:28:14 | -3.1 | 0.1 | -23.6 | 2348.2 | 88.832 | 99.844 | 58.722 | 30:36.9 |
| 20:28:15 | -3.3 | 0.1 | 0 | 2348.8 | 88.853 | 99.844 | 58.506 | 30:37.9 |
| 20:28:16 | -2.9 | -0.6 | 7.9 | 2349.8 | 88.853 | 99.844 | 58.544 | 30:38.9 |
| 20:28:17 | -3.2 | 0 | 31.5 | 2350.6 | 88.874 | 99.844 | 58.532 | 30:39.9 |
| 20:28:18 | -3.2 | -0.1 | 39.4 | 2351.2 | 88.832 | 99.79 | 58.671 | 30:40.9 |
| 20:28:19 | -3.2 | 0.2 | 31.5 | 2351.7 | 88.853 | 99.79 | 58.544 | 30:41.9 |
| 20:28:20 | -3.4 | 0 | 23.6 | 2351.3 | 88.86 | 99.763 | 58.608 | 30:42.9 |
| 20:28:21 | -3.4 | -0.2 | 3.9 | 2350.9 | 88.888 | 99.763 | 58.747 | 30:43.9 |
| 20:28:22 | -3.5 | 0.1 | -19.7 | 2350.1 | 88.881 | 99.79 | 58.848 | 30:44.9 |
| 20:28:23 | -3.3 | 0.1 | -19.7 | 2349.6 | 88.902 | 99.844 | 58.848 | 30:45.9 |
| 20:28:24 | -3.3 | -0.3 | -31.5 | 2349 | 88.881 | 99.844 | 58.671 | 30:46.9 |
| 20:28:25 | -3.3 | -0.2 | -35.4 | 2348.2 | 88.853 | 99.844 | 58.506 | 30:47.9 |
| 20:28:26 | -3.4 | -0.3 | -43.3 | 2348.3 | 88.853 | 99.79 | 58.532 | 30:48.9 |
| 20:28:27 | -3.3 | -0.3 | -35.4 | 2347.1 | 88.846 | 99.817 | 58.532 | 30:49.9 |
| 20:28:28 | -3.3 | -0.2 | -31.5 | 2347.2 | 88.853 | 99.763 | 58.633 | 30:50.9 |
| 20:28:29 | -3.1 | -0.2 | -27.6 | 2347 | 88.853 | 99.817 | 58.57 | 30:51.9 |
| 20:28:30 | -3.1 | -0.5 | -7.9 | 2347.1 | 88.86 | 99.844 | 58.57 | 30:52.9 |
| 20:28:31 | -3.2 | -0.1 | 3.9 | 2347.3 | 88.853 | 99.79 | 58.57 | 30:53.9 |
| 20:28:32 | -3.1 | -0.2 | 3.9 | 2346.8 | 88.853 | 99.763 | 58.633 | 30:54.9 |
| 20:28:33 | -3.1 | -0.1 | 7.9 | 2348 | 88.867 | 99.763 | 58.785 | 30:55.9 |
| 20:28:34 | -3.3 | -0.1 | 3.9 | 2347.2 | 88.881 | 99.763 | 58.747 | 30:56.9 |
| 20:28:35 | -3.2 | -0.4 | -3.9 | 2347 | 88.874 | 99.79 | 58.785 | 30:57.9 |
| 20:28:36 | -3.5 | -0.6 | -11.8 | 2346.3 | 88.888 | 99.79 | 58.949 | 30:58.9 |
| 20:28:37 | -3.6 | -0.6 | -43.3 | 2345.1 | 88.881 | 99.844 | 58.671 | 30:59.9 |
| 20:28:38 | -3.4 | -0.2 | -66.9 | 2344.2 | 88.839 | 99.844 | 58.494 | 31:00.9 |
| 20:28:39 | -3.1 | -1.3 | -55.1 | 2343.2 | 88.846 | 99.844 | 58.43 | 31:01.9 |
| 20:28:40 | -3.1 | -0.8 | -19.7 | 2344 | 88.825 | 99.817 | 58.506 | 31:02.9 |
| 20:28:41 | -3.2 | 0.1 | 7.9 | 2344.3 | 88.819 | 99.952 | 58.468 | 31:03.9 |
| 20:28:42 | -3.3 | -0.5 | 15.7 | 2344.7 | 88.777 | 99.925 | 58.076 | 31:04.9 |
| 20:28:43 | -2.9 | -0.7 | 23.6 | 2345.6 | 88.763 | 99.871 | 58.177 | 31:05.9 |
| 20:28:44 | -3 | -1.2 | 51.2 | 2347.2 | 88.749 | 99.871 | 57.911 | 31:06.9 |
| 20:28:45 | -3.1 | -1.9 | 66.9 | 2348.8 | 88.763 | 99.871 | 58.076 | 31:07.9 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 20:28:46 | -2.9 | -2.9 | 51.2 | 2349 | 88.77 | 99.844 | 58.089 | 31:08.9 |
| 20:28:47 | -3.1 | -3.1 | 55.1 | 2349.4 | 88.798 | 99.844 | 58.139 | 31:09.9 |
| 20:28:48 | -3.1 | -6.7 | 27.6 | 2348.8 | 88.825 | 99.844 | 58.405 | 31:10.9 |
| 20:28:49 | -4.2 | -6 | -35.4 | 2347.1 | 88.805 | 99.844 | 58.215 | 31:11.9 |
| 20:28:50 | -3.9 | -6.4 | -102.4 | 2343.8 | 88.805 | 99.925 | 58.405 | 31:12.9 |
| 20:28:51 | -4.8 | -8.6 | -157.5 | 2337.4 | 88.832 | 99.925 | 58.316 | 31:13.9 |
| 20:28:52 | -5.6 | -5.7 | -307.1 | 2332.5 | 88.735 | 99.871 | 57.797 | 31:14.9 |
| 20:28:53 | -4.8 | -9.7 | -346.5 | 2326.8 | 88.756 | 99.682 | 58.329 | 31:15.9 |
| 20:28:54 | -4.6 | -16.4 | -338.6 | 2319.4 | 88.971 | 99.79 | 59.177 | 31:16.9 |
| 20:28:55 | -6 | -13.7 | -437 | 2309.8 | 88.999 | 100.059 | 58.608 | 31:17.9 |
| 20:28:56 | -4.5 | -5.8 | -566.9 | 2306.8 | 88.632 | 100.598 | 56.38 | 31:18.9 |
| 20:28:57 | 0.5 | -10.1 | -232.3 | 2311.4 | 88.569 | 101.459 | 55.519 | 31:19.9 |
| 20:28:58 | -0.7 | -16.2 | 192.9 | 2308 | 87.364 | 102.456 | 47.582 | 31:20.9 |
| 20:28:59 | -6.5 | -4.5 | -133.9 | 2296.1 | 85.336 | 101.271 | 42.266 | 31:21.9 |
| 20:29:00 | -7.1 | -4.6 | -700.8 | 2279.8 | 84.962 | 100.302 | 42.089 | 31:22.9 |
| 20:29:01 | -6.3 | -16 | -972.4 | 2260.9 | 85.273 | 99.871 | 43.937 | 31:23.9 |
| 20:29:02 | -8.1 | -12.7 | -1129.9 | 2238 | 85.737 | 99.978 | 44.81 | 31:24.9 |
| 20:29:03 | -8.6 | -8 | -1330.7 | 2214.1 | 85.737 | 100.194 | 44.633 | 31:25.9 |
| 20:29:04 | -11.1 | -9 | -1358.3 | 2188.7 | 85.924 | 99.601 | 46.658 | 31:26.9 |
| 20:29:05 | -12.3 | -10.5 | -1570.9 | 2158.9 | 86.125 | 99.817 | 46.316 | 31:27.9 |
| 20:29:06 | -7.1 | -20.1 | -1771.7 | 2130.1 | 86.263 | 99.251 | 48.62 | 31:28.9 |
| 20:29:07 | -9.3 | -44.5 | -1720.5 | 2085.1 | 87.745 | 101.432 | 50.848 | 31:29.9 |
| 20:29:08 | -3.6 | -43.4 | -2681.1 | 2026.9 | 86.139 | 101.998 | 38.418 | 31:30.9 |
| 20:29:09 | -6.6 | -76.2 | -3503.9 | 1954.6 | 85.121 | 101.459 | 30.165 | 31:31.9 |
| 20:29:10 | -8.5 | -118.6 | -4437 | 1859.7 | 85.654 | 98.444 | 29.709 | 31:32.9 |
| 20:29:11 | -23.4 | -179 | -5692.9 | 1725.9 | 89.289 | 98.417 | 64.038 | 31:33.9 |
| 20:29:12 | -46.1 | 114.4 | -7409.4 | 1569.4 | 89.816 | 101.002 | 34.81 | 31:34.9 |
| 20:29:13 | -58.5 | 126.4 | -9838.6 | 1379.1 | 85.516 | 99.225 | 32.076 | 31:35.9 |
| 20:29:14 | -35.7 | -90.2 | -11661.4 | | 87.905 | 74.964 | 13.165 | 31:36.9 |
| 20:29:15 | | | -9657.5 | | 82.594 | 127.659 | 1.468 | 31:37.9 |
| *20:29:16*[5] | | | | | 72.221 | 112.849 | -0.152 | 31:38.9 |
| *20:29:17*[5] | | | | | 69.285 | 106.306 | -0.127 | 31:39.9 |
| *20:29:18*[5] | | | | | 72.138 | 111.53 | -0.165 | 31:40.9 |

Submitted by:
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[5] The GDU 1060 did not record beyond 20:29:15, but the next 3 seconds were added into **Table 1** for the purpose of synchronization with the EMU dataset.